BMP: PAVED FLUME

Definition

A permanent paved channel constructed on a slope.

Purpose

To conduct stormwater runoff safely down the face of a slope without causing erosion problems on or below the slope.

Conditions Where Practice Applies

Wherever concentrated stormwater runoff must be conveyed from the top to the bottom of cut or fill slopes on a permanent basis and a riprap-lined channel is not capable of conveying the runoff without erosion.

Planning-Considerations

Paved flumes are used routinely on highway cuts and fills to convey concentrated stormwater runoff from the top to the bottom of the slope without erosion. Standards and specifications have been developed for these structures which apply to all secondary and primary highway construction projects.

Consideration must be given to protecting structures against buoyancy failures. The potential for buoyancy failures due to hydrostatic uplift forces exists in channels constructed in periodically saturated areas (basically all channels will experience saturation of the subgrade by virtue of the function of the channel) and especially if a submerged outfall condition exists.

Paved flumes should be utilized and constructed carefully. Field experience has shown a significant amount of post-construction problems with these controls. If the base contains some unsuitable material or is too "soft," the flume will be subject to undermining and fracturing. There are also many cases where the outlet velocities and flow rates of stormwater which travels in a paved flume are so great that erosion and flooding at the end of the structure are inevitable, no matter what type of treatment is installed at the outlet. In these cases, strong consideration should be

given to a riprapped channel or to a system of inlets, manholes, and pipe to safely convey the stormwater to the receiving channel or drainage structure.

Design Criteria

Capacity-

Paved flumes shall be capable of passing the peak flow expected from a 10-year frequency storm.

Cross-Sections-

Figure 16-1 illustrates a typical trapezoidal cross-section of a standard paved flume. Where additional flow capacity is required, larger trapezoidal cross-sections may be designed. The following criteria apply to all trapezoidal flume designs:

1. The maximum slope of the structure shall be 1.5:1 (67%).

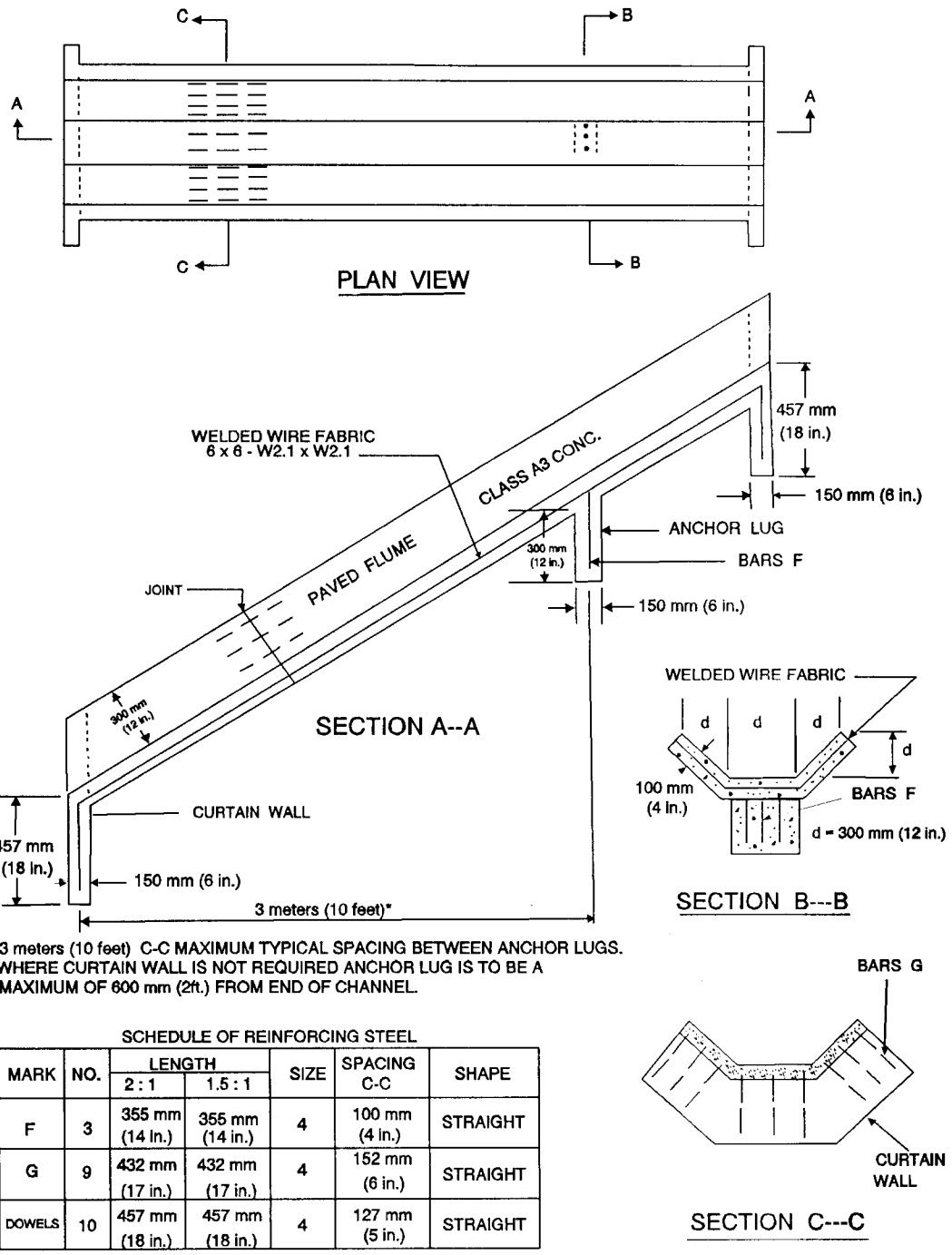
2. Curtain Walls shall be provided at the beginning and end of all paved flumes not abutted to another structure. The curtain wall shall be as wide as the flume channel, extend at least 450 millimeters (18 inches) into the soil below the channel, and have a thickness of 150 millimeters (6 inches). Curtain walls shall be reinforced with #4 reinforcing steel bars placed on 100 millimeter (4-inch) centers.

3. Anchor Lugs shall be spaced at a maximum of 3 meters (10 feet) on center for the length of the flume. Where no curtain wall is required, an anchor lug shall be installed within 600 millimeters (2 feet) of the end of the flume. Anchor lugs are to be as wide as the bottom of the flume channel, extend at least 300 millimeters (1 foot) into the soil below the channel, and have a thickness of 150 millmeters (6 inches). Anchor lugs shall be reinforced with #4 reinforcing steel bars placed on 100 millimeter (4-inch) centers.

4. The flume channel shall have at least a 100 millimeter (4-inch) thickness of class A-3 concrete with welded wire fabric 150 mm X 150 mm (6 in X 6 in) - (W2.1 x W2.1) in the center for reinforcement.

5. Expansion Joints shall be provided approximately every 30 meters (90 feet). At least 500 millimeter (18-inch) dowels of #4 reinforcing steel placed on 125 millimeter (5-inch) centers shall be located at all required joints.

FIGURE 16-1: PAVED FLUME



* 3 meters (10 feet) C-C MAXIMUM TYPICAL SPACING BETWEEN ANCHOR LUGS. WHERE CURTAIN WALL IS NOT REQUIRED ANCHOR LUG IS TO BE A MAXIMUM OF 600 mm (2ft.) FROM END OF CHANNEL.

SCHEDULE OF REINFORCING STEEL

MARK	NO.	LENGTH		SIZE	SPACING C-C	SHAPE
		2 : 1	1.5 : 1			
F	3	355 mm (14 in.)	355 mm (14 in.)	4	100 mm (4 in.)	STRAIGHT
G	9	432 mm (17 in.)	432 mm (17 in.)	4	152 mm (6 in.)	STRAIGHT
DOWELS	10	457 mm (18 in.)	457 mm (18 in.)	4	127 mm (5 in.)	STRAIGHT

NO. SHOWN ARE FOR ONE ANCHOR LUG, CURTAIN WALL AND JOINT

Outlet-

Outlets of paved flumes should be protected from erosion. The use of an energy dissipator with OUTLET PROTECTION (BMP-18) is recommended in order to temporarily reduce the existing velocity of the flow, thus preventing undermining of the structure and providing a stable transition zone between the flume and the receiving channel or drainage structure at the base of the slope. OUTLET PROTECTION should still be utilized with the use of a standard energy dissipating structure to further dissipate flow energy and to provide a smooth transition into the receiving channel. Larger energy dissipator systems may be similarly designed for larger flume cross-sections.

Construction Specifications

1. The subgrade shall be constructed to the required elevations. All soft sections and unsuitable material shall be removed and replaced with suitable material. The subgrade shall be thoroughly compacted and shaped to a smooth, uniform surface. The subgrade shall be moist at the time the concrete is poured.

2. Anchor lugs and curtain walls shall be formed to be continuous with the channel lining.

3. Traverse joints for crack control should be provided at approximately 6 meter (20-foot) intervals and when more than 45 minutes elapses between consecutive concrete placements. All sections should be at least 2 meters (6 feet) long. Crack control joints may be formed by using a 3 millimeter (1/8-inch) thick removable template, by scoring or sawing to a depth of at least 20 millimeters (3/4 inch) or by an approved "leave-in" type insert.

Maintenance

Prior to permanent stabilization of the slope, the structure should be inspected after each rainfall. Damages to the slope, flume or outlet area must be repaired immediately. After the slope is stabilized, the structure should be inspected to ensure continued adequate functioning (see potential problems noted in Planning Considerations).